Gonyodiscus cronkhitei anthonyi (Pilsbry). Verdure, San Juan Co.

Gonyodiscus shimeki cockerelli (Pilsbry). Mt. Tukuhnikivatz, LaSal Mts., San Juan Co. (V. M. Tanner Coll.). Several fine specimens (U. of U. Zool. Mus. No. 1482).

Helicodiscus eigenmanni Pilsbry. Between Blanding and Verdure, San Juan Co., one shell, immature, pale yellow in color, diameter slightly over 3 mm.; Verdure, San Juan Co., two shells, weathered and immature.

Succinea grosvenori Lea. Blanding, San Juan Co.; between Blanding and Verdure, San Juan Co.; Moab, Grand Co.

Succinea avara Say. Moab, Grand Co.; Fruita, Wayne Co.; Salina, Sevier Co.

Stagnicola (*Hinkleyia*) *caperata* Say. Moab, Grand Co.; Torrey, Wayne Co.

Fossaria parva (Lea). Moab, Grand Co.

Fossaria modicella (Say). Torrey, Wayne Co.

Gyraulus vermicularis (Gould). Price, Carbon Co.

Physella ampullacea (Gould). Moab, Grand Co.

Physella virgata (Gould). Bluff, San Juan Co.; Moab, Grand Co.; Price, Carbon Co.

EGG LAYING AND BIRTH OF YOUNG IN THREE SPECIES OF VIVIPARIDAE

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Recent observations of Frömming (Arch. f. Molluskenkunde 60:283-4, 1928) on birth in *Viviparus viviparus* led me to offer my observations on this phenomenon in other species of so-called viviparous snails for publication. Three large *Viviparus contectoides* were collected in a pond near the Zoology Building (3-26-28) and were placed in a fingerbowl of water in my laboratory. At 8.30 the next morning there were three eggs without any trace of a

vitellus, one young within the egg membrane (which emerged within three hours) and one crawling young. At 2.15 another had emerged and at 4.30 I found four unhatched young in the water. These four eggs were observed under a binocular microscope until the young emerged. The membrane of three of these eggs has fully distended, while that of the fourth was flaccid and appeared as if about one-fourth of its contents had been removed. In each case the young snails tried vainly to tear the egg membrane off by extending the foot as far caudad as possible. These attempts greatly distorted the egg, but the membrane was not ruptured until the movements of the foot were assisted by attempts to grasp it with the mouth. After about an hour of more or less constant "kicking" and biting, the membrane parted across the anterior region; then the new-born snail filled its branchial chamber with water and rested motionless for several minutes before crawling away with the membrane still clinging to its shell like a caul.

When the uterus is opened those eggs which are ready to be laid are transparent while those higher up in the tract are successively more and more nearly opaque, especially if the animal has been preserved. Since the newly laid eggs and those ready to be laid are quite transparent, one may be led to conclude that in these the albumen has been consumed and its place taken by water. However, if freshly land turgid eggs, or uterine eggs which are ready to be laid, are placed in water under a dissecting microscope and opened one can observe currents created by the fluid contents of the egg escaping into the water, very much as Frömming describes. If such eggs are placed in alcohol and quickly opened the escaping fluid is coagulated, thus suggesting that it probably contains an appreciable amount of albuminous material even at the time the young emerges.

After a number of attempts to observe the activities of unhatched uterine young, I finally succeeded in orienting a translucent egg under the binocular in such a way that the contained young was lying with its oral side up. This

youngster obligingly remained in this position so that I was able to observe it take up a mouthful of the milky fluid, "chew" a few moments, spew the remainder out and then repeat the performance again and again. Twenty-two hours later the albumen in this egg was clear, which indicated that the vegetative processes within had advanced to the stage at which the egg probably would have been laid.

The meager data at hand indicates that temperature affects the laying processes, for two large females, collected in a pond near the Zoology Building late in March, appear to have retained their eggs all winter and became active after being brought into higher temperatures of the laboratory. One of these produced 16 young four days later and two more on the fifth day. On this date she was opened and 81 eggs, 79 of which appeared ready for laying, were removed. The other individual was opened two days after having been brought into the laboratory and 129 eggs removed. Of these 122 were apparently ready for laying, 5 contained no vitelli and only two were opaque. Of the 122 eggs 89 were put in a Petri dish of water and 90 minutes later over half of them had hatched and the young were clinging to the side of the dish next to the window. The remaining 33, in a small tin dissecting tray, did not show positive phototropism definitely, however, three were crawling suspended from the surface film.

An individual collected in the same pond November 2, 1927, contained 130 eggs, 4 of which were without vitelli, 76 transparent, or nearly so, and 50 opaque. The total numbers and the proportion of transparent to opaque eggs in spring collected individuals (201:4) and in those collected in the fall (76:50) indicate that oviposition is probably discontinued during the cold months and that developmental processes are perhaps retarded but not entirely discontinued.

This appears to be the case in *V. malleatus*, for of a number collected September 22, 1928, in the old canal in Fairmount Park, the condition of uterine eggs in seven were as follows: In individual a) there were 3 transparent, no

translucent and 9 opaque eggs; b) 6, 0 and 83; c) 0, 3 and 58; d) 3, 5 and 51; e) 0, 0 and 9; f) 14, 0 and 102; g) 0, 0 and 44; h) (coll. 11-27-27) 11, 0 and 0. This gives a total of 371 eggs contained by eight snails of which approximately 89 per cent were opaque and contained very young embryos. I recall that very few opaque eggs were found in snails collected in May and June, however, I have only one record of eggs in all three stages of development. This individual was collected May 29, 1927, at the same place as the others, and all of its eggs (11) were transparent.

In *Viviparus malleatus* and *Campeloma decisum* it appears that the egg membrane is ruptured either by the young snail before being extruded or by the process of extrusion. This membrane is so delicate that one must open the fresh uterus under water to prevent all the eggs that are nearly ready to be extruded, as well as more than half of those containing very small embryos, from rupturing. The membrane of such eggs ruptures within a few minutes after the eggs have been placed in water, due, apparently, to a rapid imbibition of water by the egg. In order to prevent the egg from swelling, uteri were emptied into tap water containing, by guess, about 0.5 per cent of table salt and about 1 per cent of ethel alcohol. This anesthetized the young snails (Campeloma) and permitted me to make camera lucida outlines of them. After being transferred to fresh tap water they recovered and emerged during the night.

In one instance seven *C. decisum* uteri were emptied into a bowl of tap water and within twenty minutes 58 young were crawling up the sides of the vessel. No attempt was made to rear these young snails. However, I have frequently kept young *V. malleatus* growing in aquaria for several weeks after they had been removed from the mother. In one instance I transferred 31 young from a female to an aquarium containing tap water and only two died the first week. About ten of these were not more than two-thirds the average size of the others, which indicates the ability of this snail to live although born prematurely.

I have succeeded in keeping individuals that had been removed from the female growing in isolation eight to eleven months, but not to adult size.

My observations and experiments lead me to believe that *Viviparus contectoides* habitually extrudes its young enclosed in an egg membrane containing more or less albuminous fluid, and that it requires from a few minutes to three hours for the young snail to actually hatch after the egg has been extruded; that this membrane does not normally envelop the young of *Campeloma decisum* and *V. malleatus* at birth, and that the young of this last species probably is free of the egg membrane some time before it is extruded.

I am indebted to Dr. H. A. Pilsbry for having identified my material of *Campeloma decisum* and to Mr. E. G. Vanatta for having identified my *Viviparus contectoides* and *V. malleatus* for me.

FRESHWATER SNAILS IN BRACKISH WATER

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On a collecting trip to Bay Head on Barnegat Bay, New Jersey, on April 10, 1928, to collect marine snails, the freshwater snail *Physa heterostropha* was observed. The locality was near the mouth of the Metedeconk River, where the water is almost fresh. The specific gravity of the water at this point at another time was 1.001.

An interesting problem presented itself. Just how far into brackish water can these freshwater snails migrate? With this in view some preliminary and rather crude experiments were attempted in the summer of 1928.

The salinity of the water was gradually increased in an attempt to see if the snails could become adjusted to the salt water, and to see just how far they would go. Three species were used: *Physa heterostropha, Lymnaea stagnalis appressa* and *Lymnaea palustris* (the latter two from Michi-